

Stephen  
Cotton

5.3b

HW #8

$$\pi = CRT \Rightarrow C = \frac{\pi}{RT} = \frac{\frac{13}{760} \text{ atm}}{\frac{0.082 \text{ L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \cdot 298 \text{ K}} = \frac{7.00}{\cancel{7.00} \times 10^{-4} \frac{\text{mol}}{\text{L}}} = \frac{7.00}{\cancel{7.00} \times 10^{-4} \frac{\text{mol}}{\text{L}}}$$

$$MW = \frac{0.1 \text{ g/L}}{7.00 \times 10^{-4} \frac{\text{mol}}{\text{L}}} = \boxed{143 \frac{\text{g}}{\text{mol}}}$$

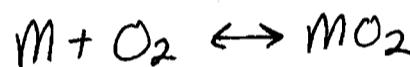
5.3c

~~$$\Delta P_{H_2O} = P_{H_2O}^{\circ} (X_{H_2O}^2 - X_{H_2O}^1) = P_{H_2O}^{\circ} ((1 - X_{cr}) - 1) = -P_{H_2O}^{\circ} \cdot X_{cr}$$~~

$$X_{cr} = \frac{7.00 \times 10^{-4} \text{ mol/L}}{55.5 \text{ mol/L}} = 1.26 \times 10^{-5}$$

$$\Delta P_{H_2O} = 23.8 \text{ torr} \cdot 1.26 \times 10^{-5} = \boxed{3.00 \times 10^{-4} \text{ torr}}$$

5.4



$$K_{eq} = \frac{(MO_2)}{(m)(O_2)}$$

$$P_{O_2} = K_H X_{O_2}$$

$$(O_2) = X_{O_2} \cdot P_{H_2O} = X_{O_2} \cdot 55.5 \frac{\text{mol}}{\text{L}}$$

$$\begin{aligned} \frac{(MO_2)}{(m)} &= K_{eq}(O_2) = K_{eq} X_{O_2} P_{H_2O} = e^{-\frac{\Delta G}{RT}} \cdot \frac{P_{O_2}}{K_H} \cdot P_{H_2O} \\ &= e^{-\frac{(-30 \text{ kJ/mol})}{2.5 \text{ kJ/J}}} \cdot \frac{\frac{30}{760} \text{ atm} \cdot 55.5 \frac{\text{mol}}{\text{L}}}{43 \times 10^3 \text{ atm}} = \boxed{8.3} \end{aligned}$$

5.10

$$(O_2) = X_{O_2} \cdot P_{H_2O} = \frac{P_{O_2}}{K_{O_2}} \cdot P_{H_2O} = \frac{0.2 \text{ atm}}{43 \times 10^3 \text{ atm}} \cdot 55.6 \frac{\text{mol}}{\text{L}} = 2.6 \times 10^{-4} \frac{\text{mol}}{\text{L}}$$

$$(N_2) = \frac{P_{N_2}}{K_{N_2}} \cdot P_{H_2O} = \frac{0.75 \text{ atm}}{86 \times 10^3 \text{ atm}} \cdot 55.6 \frac{\text{mol}}{\text{L}} = 4.8 \times 10^{-4} \frac{\text{mol}}{\text{L}}$$

$$(CO_2) = \frac{P_{CO_2}}{K_{CO_2}} \cdot P_{H_2O} = \frac{0.05 \text{ atm}}{1.6 \times 10^3 \text{ atm}} \cdot 55.6 \frac{\text{mol}}{\text{L}} = 1.7 \times 10^{-3} \frac{\text{mol}}{\text{L}}$$

(b)

$$(gases) = (O_2) + (N_2) + (CO_2) = 2.4 \times 10^{-3} \text{ M}$$

$$X_{gases} = \frac{(gases)}{P_{H_2O}} = 4.4 \times 10^{-5}$$

$$P_{H_2O} = X_{H_2O} P_{H_2O}^0 = (1 - 4.4 \times 10^{-5}) \cdot 23.756 \text{ torr}$$

$$= 23.755 \text{ torr}$$

5.12

$$(a) \ln(a) = \frac{-\pi V}{RT} ; \ln(a) = \frac{\Delta H_{fus}}{R} \left( \frac{1}{T_0} - \frac{1}{T_f} \right)$$

$$\Rightarrow \pi = -\frac{RT}{V} \ln(a) = -\frac{RT}{V} \frac{\Delta H_{fus}}{R} \left( \frac{1}{T_0} - \frac{1}{T_f} \right) = -\frac{\Delta H_{fus}}{V} \cdot T \cdot \left( \frac{1}{T_0} - \frac{1}{T_f} \right)$$

(b) Since the total # of moles must be equal in both solutions:

$$\frac{wt. \Delta^\circ NaCl}{wt. \Delta^\circ Sucrose} = \frac{MW NaCl}{MW Sucrose}$$

$$= -\frac{6 \frac{kJ}{mol}}{\frac{1 L}{55.6 \text{ mol}}} \cdot 298.15 \text{ K} \cdot \left( \frac{1}{273.15 \text{ K}} - \frac{1}{272.74 \text{ K}} \right)$$

$$= 0.54 \frac{kJ}{L} \approx 5.4 \text{ atm}$$

$$\Rightarrow wt. \Delta^\circ Sucrose = \frac{MW Sucrose}{MW NaCl} \cdot wt. \Delta^\circ NaCl$$

$$= \frac{342}{58.5} \cdot 0.7 \Delta^\circ = [4 \Delta^\circ sucrose]$$

5.19

How much  $N_2$  is liberated when diver goes from  $P_1$  to  $P_2$ ?

$$P_1 = X \cdot P_{\text{tot}} = X \cdot \rho g h$$

$$= 0.78 \cdot \frac{1000 \text{ kg}}{\text{m}^3} \cdot \frac{9.8 \text{ m}}{\text{s}^2} \cdot 300 \text{ m} \cdot \left( \frac{1 \text{ atm}}{105 \text{ N/m}^2} \right)$$

$$= [23 \text{ atm}]$$

$$P_2 = X \cdot P_{\text{tot}}$$

$$= 0.78 \cdot 1 \text{ atm}$$

$$= [0.78 \text{ atm}]$$

$$K_{N_2} = \frac{P_{N_2}}{X_{N_2}} = \frac{0.78 \text{ atm}}{0.013} = 60 \text{ atm}$$

$$\Delta V_{N_2} = V_{\text{tot}} \cdot \Delta X_{N_2} = V_{\text{tot}} \cdot \frac{\Delta P_{N_2}}{K_{N_2}} = 3.2L \cdot \frac{(0.78 - 23) \text{ atm}}{60 \text{ atm}}$$

$$= -1.2L$$

$\therefore [1.2L N_2 \text{ Liberated}]$

5.30

(a) How does the total surface area change if and the total volume remains constant?

$$2V_2 = V_1 \Rightarrow 2 \cdot \frac{4}{3} \pi r_2^3 = \frac{4}{3} \pi r_1^3 \Rightarrow r_2 = \left(\frac{1}{2}\right)^{1/3} r_1$$

$$\Delta S = 2S_2 - S_1 = 2 \cdot 4\pi r_2^2 - 4\pi r_1^2 = 4\pi (2r_2^2 - r_1^2)$$

$$= 4\pi \left(2\left(\frac{1}{2}\right)^{2/3} - 1\right) r_1^2 = [3.3 r_1^2]$$

$$r_1 = \frac{1}{2} \times 10^{-6} \text{ m}$$

$$\text{Work} = \Delta S \cdot T = 3.3 \cdot \left(\frac{1}{2} \times 10^{-6} \text{ m}\right) \cdot 12.3 \times 10^{-3} \frac{\text{N}}{\text{m}} = [1.0 \times 10^{-14} \text{ J}]$$

(b)

$$\frac{1.0 \times 10^{-14} \text{ J}}{1 \text{ mol}} = 4 \times 10^{-19} \text{ mol} = [2.4 \times 10^5 \text{ molecules of } N_2]$$